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A Fully Automatic Change Detection Method for Large-Scale Flood Record Generation using SAR Data: UK as a Test Case

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Earth Observation (EO) satellites have been operated for a century and a large amount of EO data with global coverage is available nowadays. Previous studies have focussed on the development and evaluation of algorithms using optical and Synthetic Aperture Radar (SAR) data in the field of flood mapping. When compared with optical data, SAR data has as main advantages that it can be acquired with equal quality regardless of the sun-illumination and weather conditions. Moreover, the low backscatter generated by calm and open water bodies allows them to be separated from other land cover classes.
Most of the flood mapping methods have been developed for specific regions and specific flood events and may thus be not suitable for large scale applications. Moreover, systematic and fully automated applications of flood mapping algorithms on large datasets are still rare. In the previous studies, change detection was widely used since the number of false alarms caused by water lookalike areas (e.g. vegetated areas, tarmac, shadow regions) can be reduced rather easily. However, the selection of an adequate reference image remains a critical issue since the accuracy of the final flood extent map clearly depends on the selected reference image. Several indices for selecting reference images have been proposed in the literature and can be applied as part of an automatic change detection method with the previously determined flooded image. Moreover, when it comes to the generation of a flood record at the global scale using large collections of SAR images, the so-called ‘flood images’ are generally unknown a priori. Overall, two unknowns thus exist in any change detection-based flood mapping application based on large SAR datasets: the image acquired during the flood event and the corresponding optimal reference image. To address the problems mentioned above, we propose a fully automatic change detection method, consisting of three main processing steps: (i) flood image identification; (ii) reference image selection; (iii) flood mapping using change detection.
Images from different ENVISAT orbital tracks over the UK have been processed with the proposed method. Due to a lack of ground truth data at equally large scale, we adopted a two-step approach for evaluating the resulting flood maps covering the 405 km swath width. First, subsets of the flood maps over the flooded regions are evaluated using a flood extent map derived from high-resolution aerial imagery. Next, for the other regions and images without any ground truth data, flood maps derived from a hydraulic model are considered for the evaluation. According to our results, the overall accuracies of two flood maps’ subsets are higher than 85% while the users’ accuracies of the flood class are higher than 88%. Moreover, a good agreement has been found between the entire frame of SAR-derived flood maps and model-derived results published by the Environment Agency. The experimental results over the UK indicate that the proposed method has a great potential to generate a global flood record from the large collection of SAR datasets.